Massive Potential for the Internet of Things
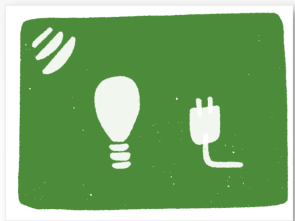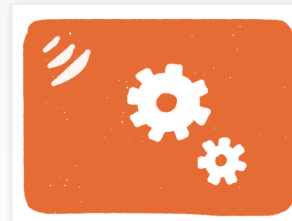

Smart Homes

Wearables

Healthcare

Power & Environment

Smart Cities

Manufacturing

The Internet of Things – Bridging the Silos

Still very immature, and a long way to go

Lack of interoperability at the application level

Many platforms and associated standards
- Addressing broad range of different requirements
- End to end security challenging across platforms

Fragmentation and Silos are holding back the potential
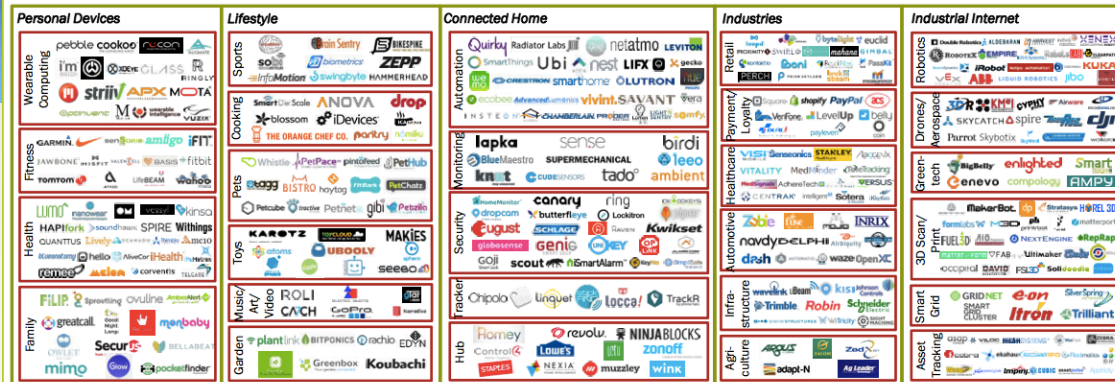- This is causing problems for start-ups and SMEs

Open or closed system?
- Closed systems incentive: control
- Open systems prompt: reduced costs and increased market size

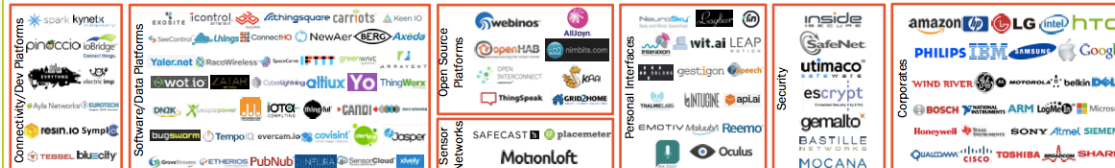- Need for wide adoption of shared open standards

IoT Landscape
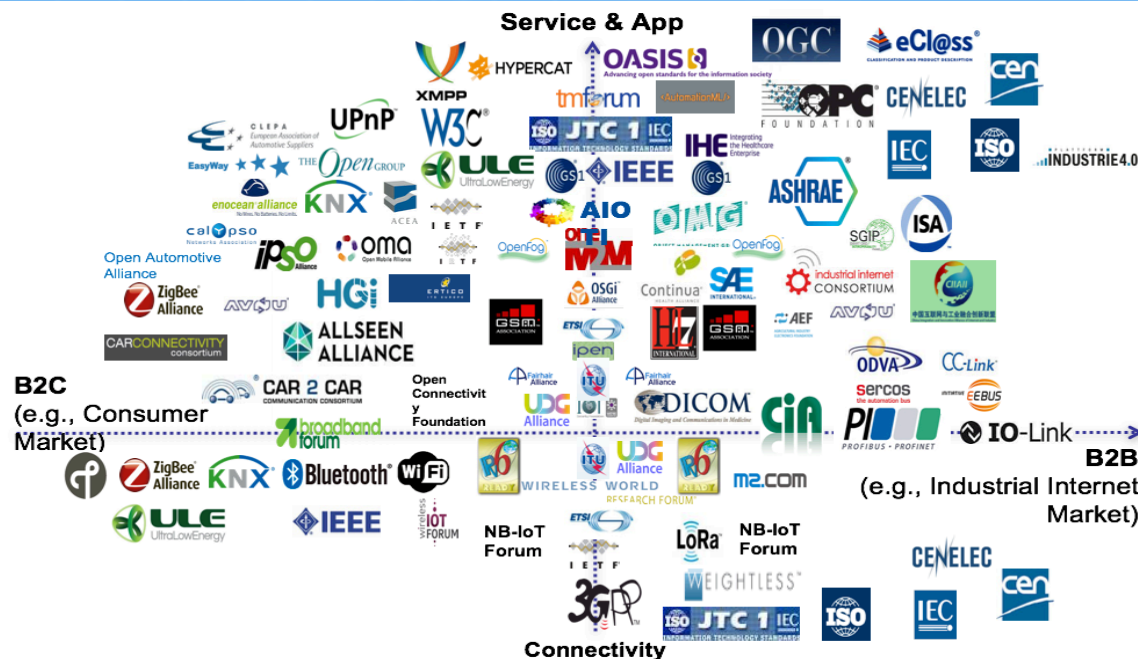
IoT SDOs and Alliances Landscape

World Wide Web Consortium

Mission: lead the Web to its full potential

- The Web is the world's largest vendor-neutral distributed application platform

Founded by Sir Tim Berners-Lee, inventor of the Web

- 400+ Members
- Member-funded international organisation

Develops standards for Web and semantic technologies

- HTML, CSS, scripting APIs, XML, SVG, VoiceXML, Semantic Web and Linked Data etc.
- Developer oriented, enabling cooperation between organisations with very different backgrounds
- W3C patent policy for royalty free standards
- W3C staff of engineers actively participating in standardisation
- Increasingly involved in verticals: Mobile, TV, Automotive, Digital publishing

What we want to avoid …
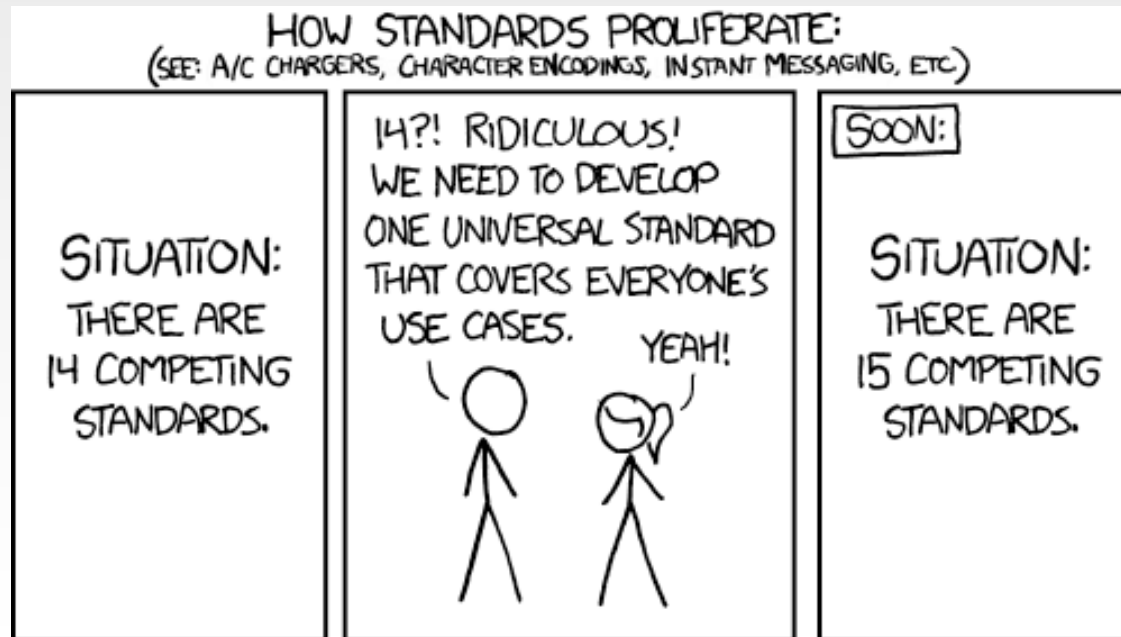
Web of Things – Inter-Platform standards for interoperability

The Web will enable a transition from costly monolithic software to open markets of apps

Analogy with early days of networking

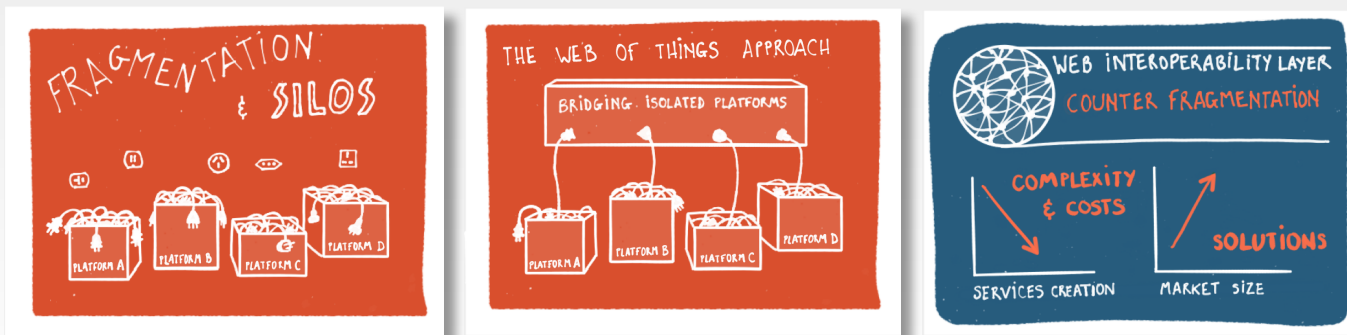Before the Internet, there were many non-interoperable network technologies

- IP made it simple to interconnect networks and create interoperable services independent of the network technologies
- The Internet grew exponentially as the opportunities were realised
- Likewise for the Web which took over from isolated information services

Direct analogy with today's IoT silos
and their lack of interoperability

- The Web of Things is the equivalent of IP for semantic interoperability and end to end security
- The Web of Things will enable explosive growth as the barriers to interoperability are torn down

The Web of Things – countering fragmentation with standardised metadata and APIs

- **Simplifying application development by decoupling the underlying protocols**

  - By analogy to the cross platform sockets API for the Internet Protocol

  - Making It easy to write apps that can be easily ported across platforms

- **Enabling interoperability across different platforms with standardised metadata**

  - Describing the interfaces exposed to applications

  - Describing the communication and security requirements for accessing things

  - Describing the semantic models and domain constraints

Web of Things

THING = PHYSICAL OR ABSTRACT ENTITY

TEMPERATURE SENSOR

THING DESCRIPTOR (RDF)
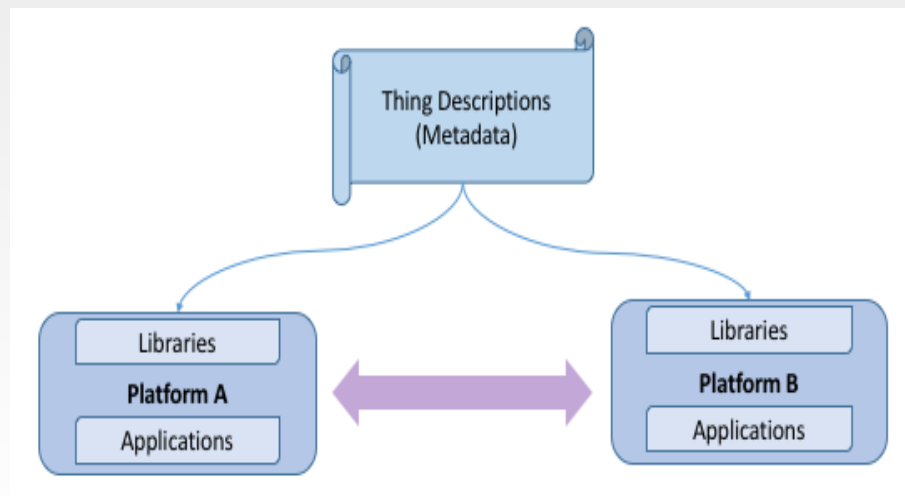
SOFTWARE OBJECT
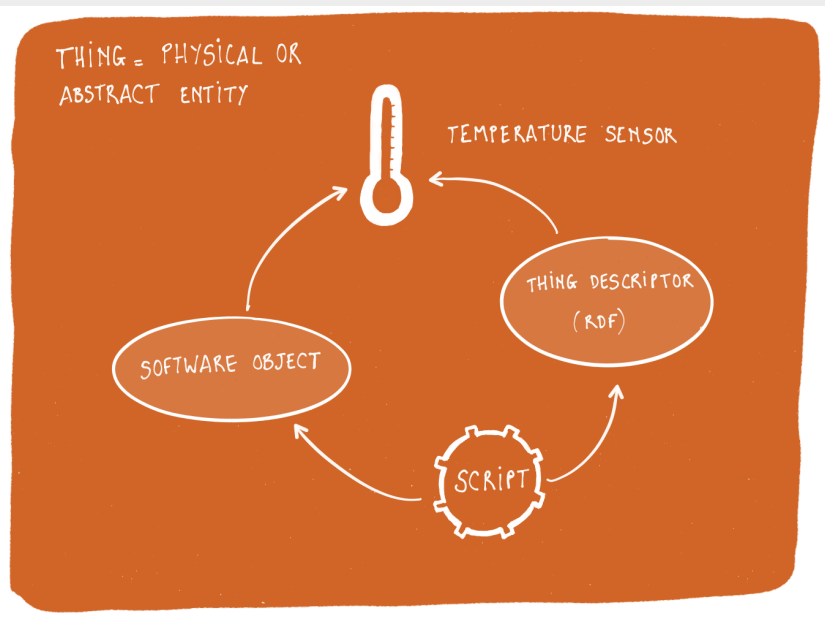
SCRIPT

Applications act on software objects that stand for things

- Local "things"
- Remote "things

Rich descriptions for every "thing"

- Each thing has a URI for its name
- This provides access to its description
- Ontologies that describe "things"

Things don't need to be connected

- Abstract entities and unconnected physical objects

Sensor Data Streams and the Cloud

- Device – Gateway – Cloud
  - IoT devices with local connectivity
  - Gateways that stream sensor data to the cloud
  - Powerful scalable cloud based platforms

- Opportunities for services across many application domains

- Big data, stream analytics and advanced AI
  - Machine learning and personalised services

- Need for open standards to create open markets of services that span cloud platforms operated by different vendors
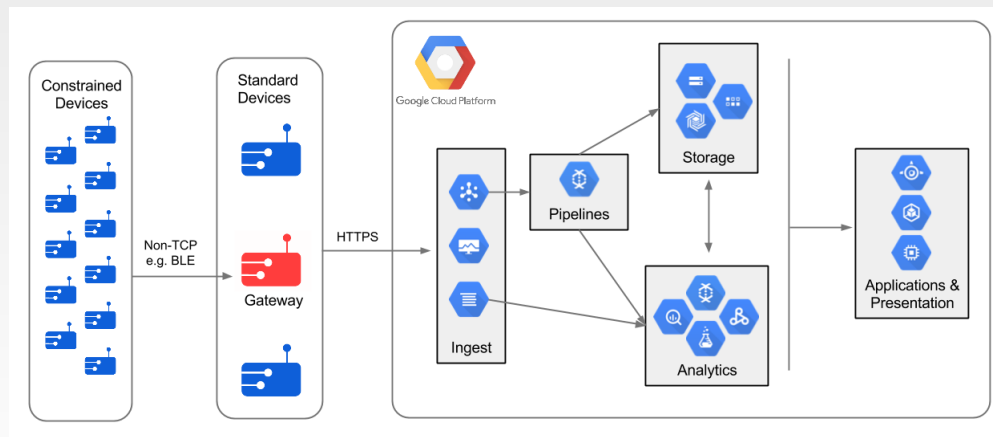
Google's Cloud Platform for the IoT

Hubs as Platforms for Smart Home Apps

- Web standards can create opportunities for vendor neutral platforms for a market of apps for installation on your home hub

- Your smart phone provides the human machine interface for these apps

- Improved sense of privacy compared with having your personal data being sent to the cloud

- Apps based upon your social connections
  - Peer to peer with your friend's home hubs
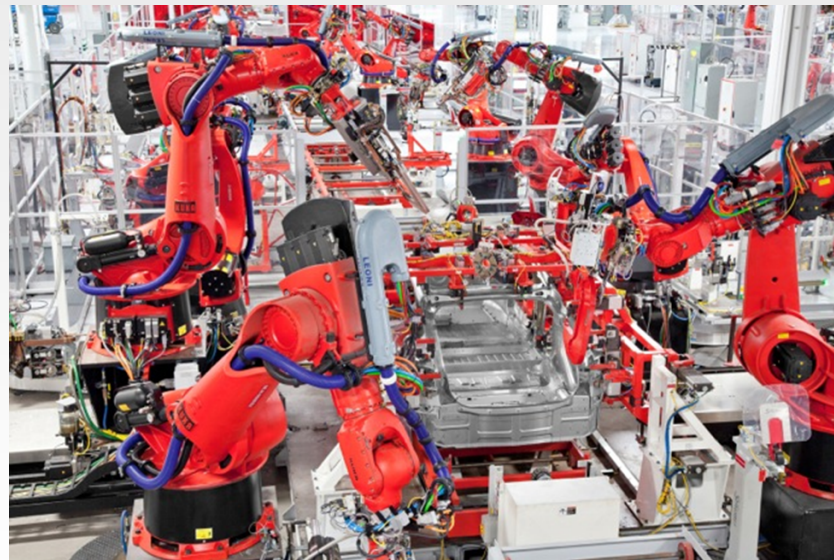

Samsung's Smart Things

Smart Manufacturing

- Greater flexibility to address the trend to highly personalised products

- Reacting faster to changing market conditions

- Vertical integration from production cells to the board room

- Horizontal integration across both the supply chain and the value chain within a business

Robots manufacturing Tesla's electric cars

What kinds of metadata do we need?

- Thing lifecycles, data and interaction models
  - As exposed to the applications
    - Properties, actions and events

- How to interoperate with another platform?
  - Protocols, data formats and so forth

- What communication patterns to use?
  - Push, pull, pub-sub, peer to peer
  - Real-time requirements
  - Transactional robustness & rollbacks
  - Multiplexing and buffering
  - Sleepy ambient & battery powered devices

- Semantic models of things and their constraints

Semantic Models

- Needed to ensure that platforms share the same meaning for the data that they exchange

- For discovering things based upon their properties and relationships
  - Search engines that can index the Web of Things

- For verifying that a thing is consistent with given models

- For designing service compositions based upon the knowledge of which services are compatible

- This may involve transformation of data formats
  - Automatic generation of glue code from the metadata
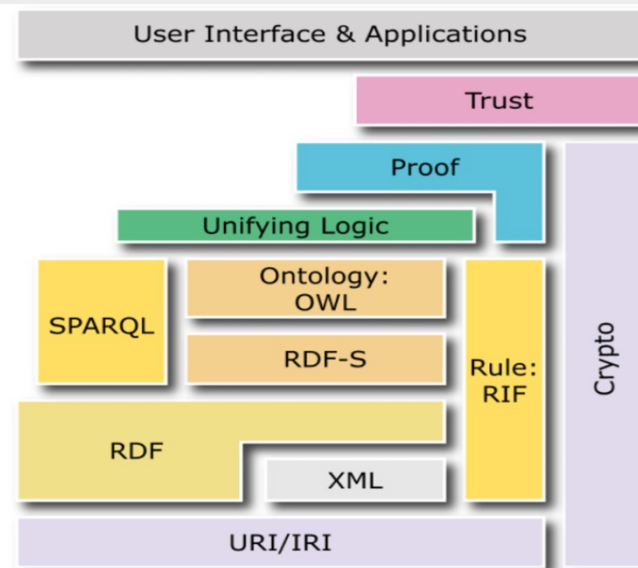
W3C has a rich suite of related standards

IoT Security Should Worry Us All

- Breaches of privacy

- Cybercrime

- Physical safety in the home, across the city and within businesses

- Threats to national infrastructure

- Looming risks of cyberwar

Need for joint work on best practices and technical standards

W3C Web of Things

Activity

W3C Web of Things Interest Group

Workshop in Berlin (June 2014)

- Launch of Web of Things IG in 2015
- Chaired by Jörg Heuer, Siemens
- Task forces

    Thing descriptions

    APIs and protocols

    Discovery and provisioning

    Security, privacy and resilience

    Communications and collaboration

Strong emphasis on implementation experience

- Demos and plug-fests
- Helps to build a shared understanding

Beijing Face to Face, 11-14 July 2016

# Members of the Web of Things Interest Group

Where Next? W3C Web of Things Activity

- W3C is chartering a Web of Things Working Group to develop initial standards
  - Charter currently under review by W3C Members

- W3C Web of Things Interest Group has just rechartered
  - Expected to boost its work on reaching out to industry alliances and SDOs
  - Interoperability tests across platforms using open source implementations
  - Further work on semantics, security and privacy

- Plans for an IoT on the Web Business Group
  - Focusing on business level requirements across domains
  - Building a shared understanding through collaboration with external groups

IoT SDOs and Alliances Landscape
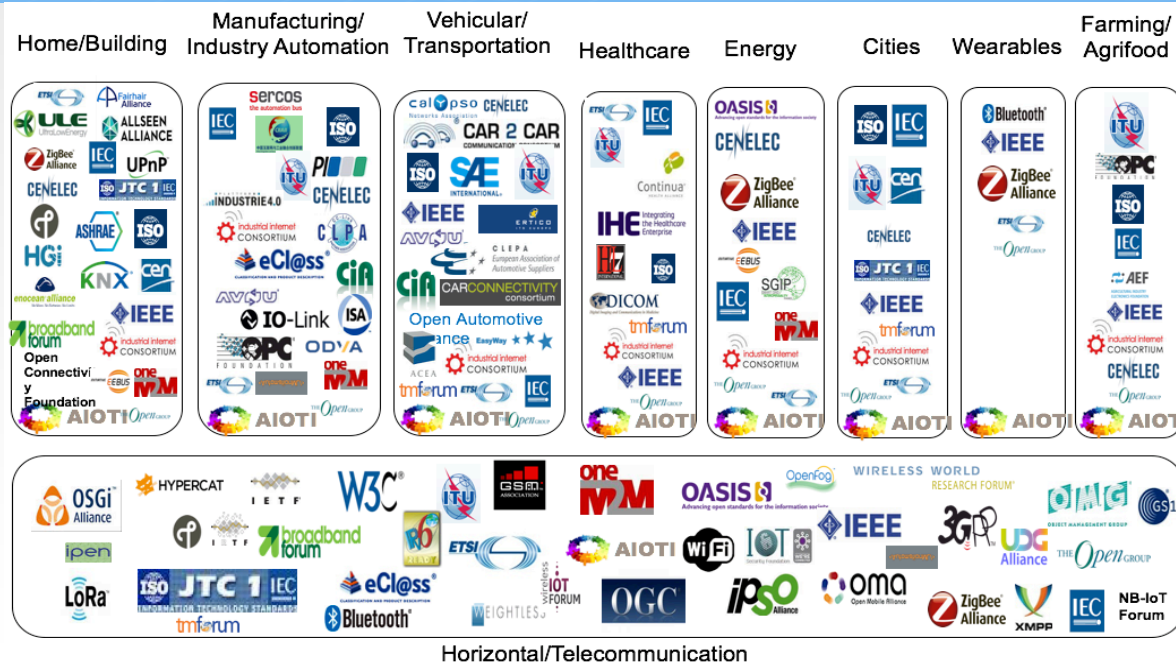
Agile Processes for Standardisation

- Today, several IoT alliances and standards development organisations are working on models as descriptions of devices and services

- Organisations are working on this in isolation with risk of fragmentation

- Joint white paper on semantic interoperability to counter this
  - Building a shared understanding of the role of semantic interoperability
  - See http://dx.doi.org/10.13140/RG.2.2.25758.13122

- Discussion underway on next steps to keep the momentum flowing

- We need agile processes for vocabulary development that meets the timescales and business realities facing SMEs
  - Experimental, early commercial use, widespread use
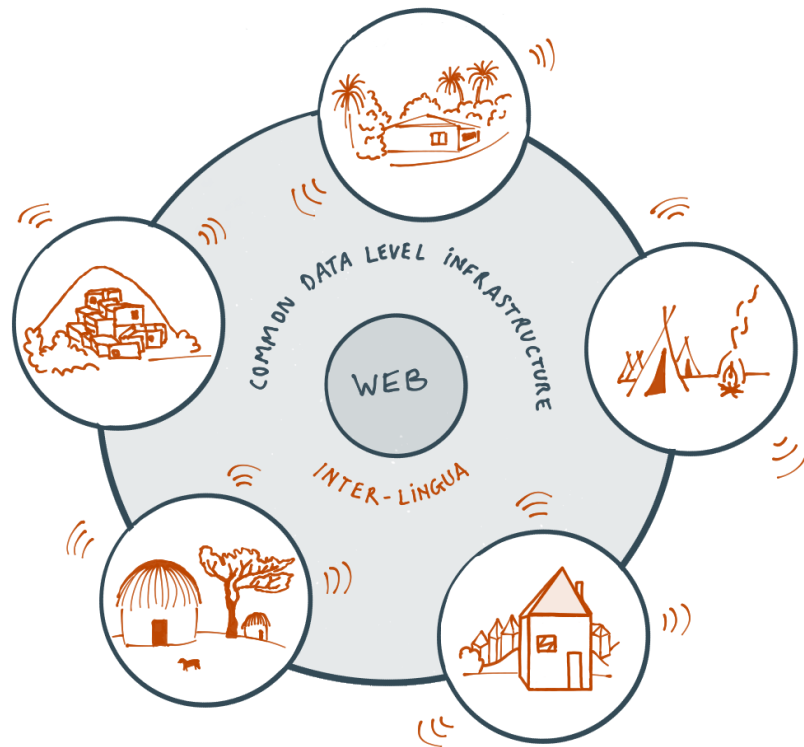 - Encouraging re-use where practical

The Bottom Line

The Web is essential for realizing the full potential of the IoT

The Web provides a unifying framework for semantic interoperability

The Web acts as a global marketplace for suppliers and consumers of services

Workshop Agenda

Industrial Perspective

- Needs, gaps, current state and future approaches
  - Boris Maurer, Connctd
  - Colin l'Anson, HPE
  - Frank Reusch, RWE/Lemonbeat
  - Dieter Wegener, Siemens

- Discussion lead by Dave Raggett & Georg Rehm

How to Coordinate?

- Views from different organisations
  - Stefan Hoppe, OPC Foundation
  - Stefan Weisgerber, DIN
  - Thomas Hahn, Plattform Industrie 4.0

- Discussion lead by Dave Raggett & Georg Rehm

- Workshop conclusions and wrap-up

The industrial perspective – needs and gaps, current state, future approaches

- **Is there a shared understanding of what semantic interoperability is and why it is important?**

- Each platform has by and large approached security independently, what are the key considerations for enabling end to end security across platforms?

- Industry 4.0 has been very high level to date, how do we proceed to a rich set of use cases that add detail to the vision we want to realize, point to the requirements, and facilitate a better understanding of which existing standards are appropriate and what new standards are needed?

- Can you talk about the different kinds of platforms and standards that are needed to reach from the productions cells to the board room, to reach across supply lines and corporate value chains, and across the life cycle from product design, production planning and operation, and lifetime support?

- How do we convince companies to commit the resources to drive new technical standards for the IIOT?

- What is needed for companies to collaborate on building commercially relevant testbeds for the IIOT?

How do we coordinate ourselves to standardize semantic interoperability?

- Why is coordination essential, and across which bodies should it take place?

- What are the appropriate mechanisms for collaboration? For example, joint white papers, workshops, joint testbeds, plugfests, bilateral meetings, etc.

- What kinds of people do we need to involve and what are the arguments that are needed to convince businesses to make the necessary commitments?

- What is the roadmap for the Industrial Internet of Things? Can we combine a broad longer term vision with readily achievable milestones along the way?

- More concretely, what is needed for building a shared vision between the Industrial Internet Consortium, Industrie 4.0, OPC Foundation and W3C, amongst others?